ENERGY UPGRADING

OF
BUILDINGS WITH CENTRAL UTILITIES

FUNDED UNDER NHA PROGRAMS

PHASE II

Prepared for

the Research Division

Policy Development and Research Sector

Canada Mortgage and Housing Corporation

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ABSTRACT

The Canada Mortgage and Housing Corporation provides operating subsidies to provincial housing agencies for approximately 145,000 housing units in 1,650 residential buildings with central utilities. A 10% energy cost savings of $10,000,000 is estimated through the application of no cost/low cost energy conservation measures. Measures implemented in 1984 in 30 buildings in Alberta, Quebec and British Columbia yielded savings of 5%. A 8% savings is realistic following the application of all no cost/low cost measures. A computer based energy monitoring system is essential to a successfull energy management program. A training program for local building managers is necessary and very effective. Total cost of energy measures implemented in 1984 was $51,000. Total savings were $62,000 in one year.

EXECUTIVE SUMMARY

The Canada Mortgage and Housing Corporation through NHA programs provides operating cost subsidies to provincial housing agencies for approximately 1 650 residential buildings with central utilities ranging in size from 5 units to over 200 units. In response to rising energy costs CMHC undertook in 1983 to investigate the potential for cost savings in these buildings. The first phase of this study was completed in 1983. A report published by CMHC in November 1983 entitled "Energy Upgrading of Buildings with Central Utilities under NHA Programs" indicated that the annual energy cost savings potential was 10% which is $10 million dollars for approximately 145 000 housing units in the 1 650 buildings.

In order to confirm this potential, phase 2 of this study was undertaken in 1984. Thirty buildings, jointly owned or financed by CMHC and provincial housing corporations were selected in the provinces of British Columbia, Alberta and Quebec for a field study. The British Columbia Housing Management Commission, the Alberta Mortgage and Housing Corporation, and the Société d'habitation du Québec, agreed to participate in the study.

Phase 1 had recommended that no cost/low cost energy conservation measures be identified and implemented by the local building managers wherever possible, and that a comprehensive energy management program involve all levels of management.

Information and training was provided to the individuals responsible for each of the 30 buildings to allow them to identify and implement measures over a period of 12 months, and monitor the energy cost savings over that period.

Phase 1 had recommended that a centralized computer based energy monitoring program be jointly implemented by CMHC and the provincial housing agencies. A goal of the second phase was therefore to field test a computer based energy monitoring system. A consultant, Engineering Interfaced Limited of Toronto, was selected to demonstrate their proprietary system and to assist the provincial housing agencies in their preliminary investigations into computer based systems appropriate to their needs.

A program of information transfer and training was provided over the course of the 12 month trial to the individual building operators. The program included intensive one or two day workshops; direct assistance from provincial housing authority technical staff; and direct assistance from local consultants, only if necessary to investigate complex measures. Individual building managers in the provinces of Quebec and Alberta worked independently throughout the course of the study. In British Columbia it was concluded at an early stage that, in view of the British Columbia Housing Management Commission administrative structure, it would be not effective to allow individual building managers to work independently. Thus, a centralized approach to identifying energy savings measures was adopted.

Each building manager in Quebec and Alberta identified and implemented measures over the course of the 12 month study period, depending on the availability of funds and the amount of time that could be made available to the project. Thus, measures were implemented throughout the year. The monitoring program however was structured to compare the 1983 energy year as a base year, to the 1984 trial year.

Energy usage in 1984 after normalization for weather differences and energy unit cost differences was down slightly on average as compared to 1983. Savings in the 20 buildings in British Columbia and Alberta heated by natural gas were an average 4.5%. Savings in the 10 all electric buildings in Quebec were only 1%. The low savings in Quebec can be attributed to the late implementation of measures due to funding constraints at the local level and to the relatively energy efficient nature of the buildings. In general, only no cost measures were implemented in Quebec where as no cost/low cost measures were implemented in Alberta and British Columbia.

The actual 1984 dollar savings in the set of 20 gas heated buildings in Alberta and British Columbia was $60,784. The actual savings in the set of 10 Quebec buildings was $1,575.

The total cost of energy measures implemented in 1984 was $51,000. Total savings realized during 1984 were $62,000. Simple payback is therefore slightly less than 1 year. Estimated savings for 1985, based on measures implemented in 1984 and early 1985 are 8% which is $110,000. The 1984

savings were approximately half of what had been estimated for the year if all measures had been implemented at the beginning of the year.

In conclusion, energy cost reductions of 8% in buildings with central utilities is realistic through no cost/low cost retrofit measures. The average retrofit cost was $1,700 per building. Payback period was one year.

A future program based on the direct involvement of individual building managers to identify and implement measures is feasible and preferrable where provincial administrative procedures allow it. Through training and experience, individual building operators can identify measures over several years and can ensure that measures already implemented are maintained.

Energy monitoring on a year-to-year basis normalized for changes in weather and energy costs is essential to verify the effectiveness of measures implemented and to maintain momentum and interest in the program.

Funding for retrofit measures was a constraint in some buildings and funding sources should be made available to local housing authorities specifically for the implementation of energy savings measures. This funding however, should be linked to performance reporting and energy cost reductions.

It is recommended that the 30 buildings should be monitored for a further 12 month period to verify the long term effectiveness of the measures implemented over the course of the study year. It is also recommended that CMHC

assist the provincial housing authorities in all provinces and the territories to implement a computer based energy monitoring program meeting their requirements over the next few years.

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Alberta Housing Corporation

B.C. Housing Management Commission

Calgary Housing Authority

Grace Church Housing Society

FLT Building Society

Metropolitan Calgary Foundation

Ontario Housing Corporation

Société d'Habitation du Québec

Québec Municipal Housing Authorities for Québec City,

Sept Isles, Verdun, Drummondville, Lauzon and Levis

Roman Catholic Diocese of Calgary Association

Trinity Place Foundation

1.0 INTRODUCTION

The Phase I study on "Energy Upgrading of Buildings with Central Utilities Funded under NHA Programs" was completed in 1983. It identified annual energy cost savings of 10% which is $10 million for 145,000 public housing units in approximately 1,650 buildings ranging in size from five units to over two hundred units. The energy cost savings estimate was on the application of low-cost/no-cost energy conservation measures. In order to realize the energy cost savings, a comprehensive energy management program was recommended.

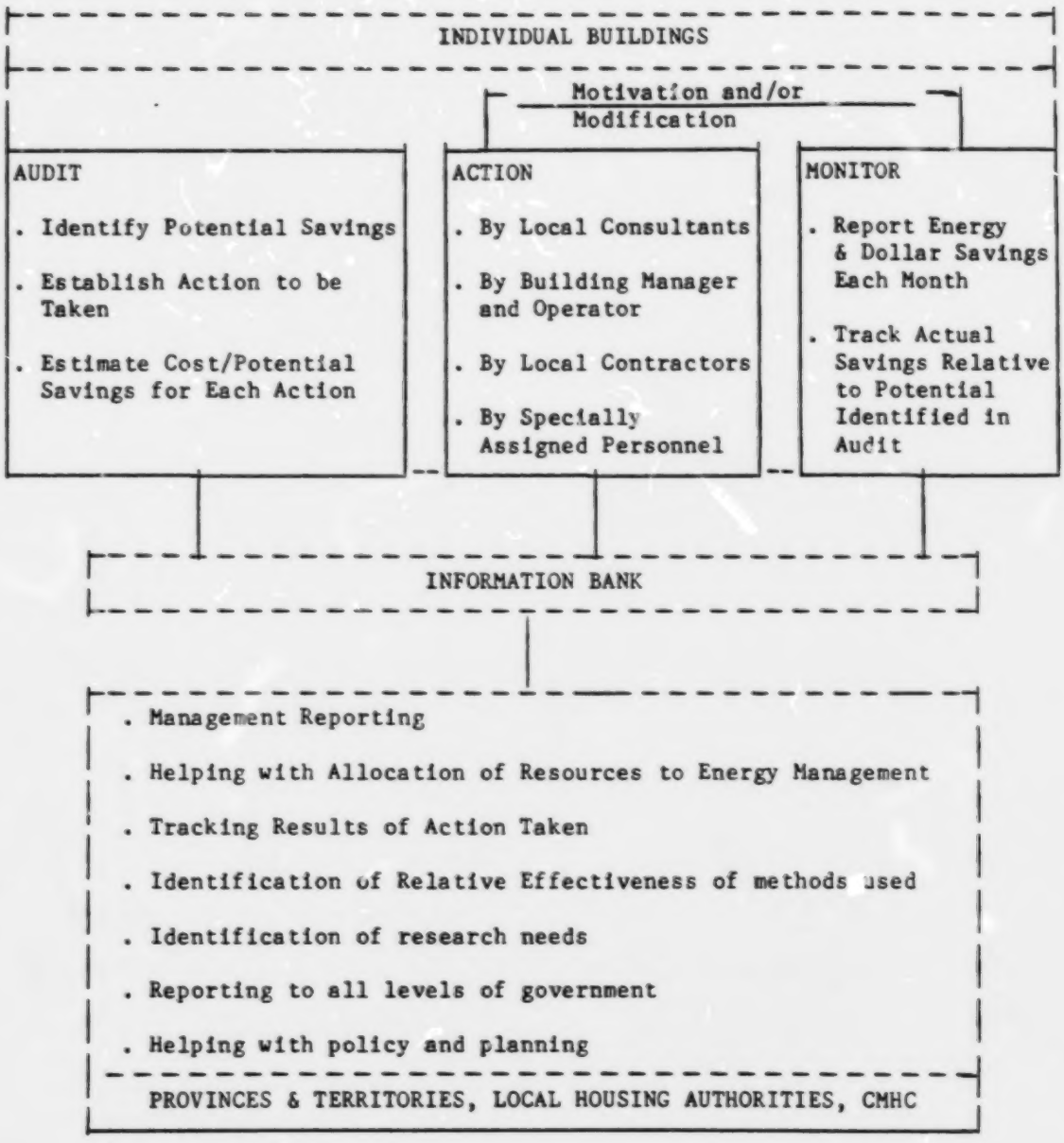
The recommended energy management program contained the following elements:

- an energy audit of existing energy use,
- an energy target to establish a goal,
- action programs for building managers,
- an information database for management reporting, and
- an energy monitor to track actual energy savings produced by action programs.

The energy management program model is outlined in Figure 1.

The objective of the Phase II study is to field test and refine the energy management model in a sample of NHA funded multi-unit residential buildings in Canada.

FIGURE 1


INDIVIDUAL BUILDINGS
Motivation and/or Modification
AUDIT
. Identify Potential Savings
. Establish Action to be Taken
. Estimate Cost/Potential Savings for Each Action
ACTION
. By Local Consultants
. By Building Manager and Operator
. By Local Contractors
. By Specially Assigned Personnel
MONITOR
. Report Energy & Dollar Savings Each Month
. Track Actual Savings Relative to Potential Identified in Audit
INFORMATION BANK
. Management Reporting
. Helping with Allocation of Resources to Energy Management
. Tracking Results of Action Taken
. Identification of Relative Effectiveness of methods used
. Identification of research needs
. Reporting to all levels of government
. Helping with policy and planning
PROVINCES & TERRITORIES, LOCAL HOUSING AUTHORITIES, CMHC

AN ENERGY MANAGEMENT MODEL FOR
MULTI-UNIT PUBLIC HOUSING IN CANADA

2.0 PROJECT METHODOLOGY FOR PHASE II

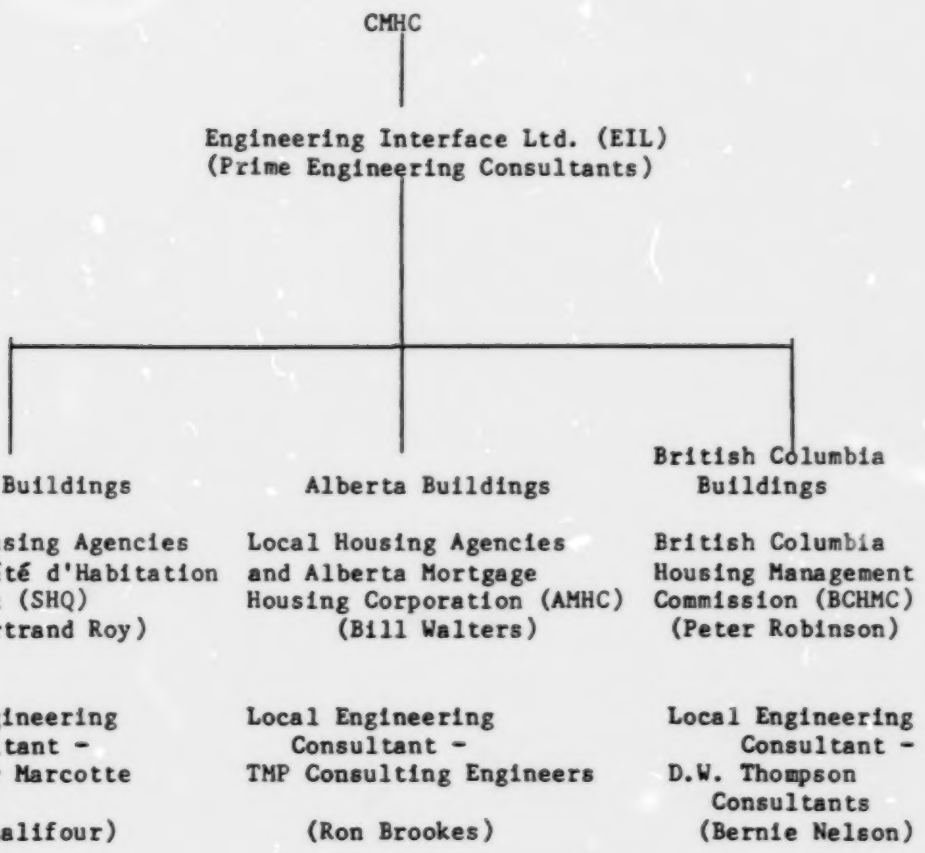
2.1 Project Objectives

The objectives of the Phase II study were:

1. To test and evaluate the energy management model concepts using a pilot program for thirty multi-unit residential buildings;
2. To transfer information and technology to participating local housing authorities and local consultants;
3. To identify measurable energy cost savings in the thirty buildings;
4. To achieve measurable energy cost savings;
5. To refine the estimate of attainable energy cost savings in the multi-unit public housing stock; and
6. To encourage the development of a comprehensive energy management program at the local housing authority level.

2.2 Participants

The project involved three provinces and three local engineering consultants. The project team is outlined below:


CMHC
Engineering Interface Ltd. (EIL)
(Prime Engineering Consultants)
Quebec Buildings
Alberta Buildings
British Columbia Buildings
Local Housing Agencies and Société d'Habitation du Québec (SHQ)
(Bertrand Roy)
Local Housing Agencies and Alberta Mortgage Housing Corporation (AMHC)
(Bill Walters)
British Columbia Housing Management Commission (BCHMC)
(Peter Robinson)
Local Engineering Consultant - Chalifour Marcotte Assoc.
(Andre Chalifour)
Local Engineering Consultant - TMP Consulting Engineers
(Ron Brookes)
Local Engineering Consultant - D.W. Thompson Consultants
(Bernie Nelson)

2.3 Building Selection

The project involved the selection of thirty multi-unit residential buildings with central utilities from the NHA building stock administered by the three provincial housing authorities. Ten buildings were selected from British Columbia, Alberta and Quebec, respectively, to provide a representative cross-section of the total building stock. Low-rise, mid-rise and high-rise multi-unit buildings were selected. Building selection was limited to the major urban centres of each province to minimize travel time.

British Columbia buildings were chosen from the Vancouver metropolitan area. Alberta buildings were chosen from the Calgary metropolitan area. Quebec buildings were chosen from the Montreal, Quebec City and Sept-Isle areas.

Quebec buildings are electrically heated, whereas B.C. and Alberta buildings are gas heated.

2.4 Tasks

The project methodology and schedule are outlined below:

TASK	RESPONSIBILITY	TIMETABLE
. Building Selection Process: select thirty buildings; review project plan	CMHC, EIL, Local Housing Authority, Local Consultant	Dec./83
. Data Collection: collect building characteristics; collect building energy records	Local Consultant, Local Housing Authority	Jan. 1/84 to Feb. 1/84
. Energy Audit/Energy Target: prepare Audit and Energy Target; create Energy Database	EIL	Feb. 1/84 to Feb. 20/84
. Workshop Presentation #1: review program objectives; review typical energy conservation measures; review energy target and potential energy cost savings; define site visit requirements	CMHC, EIL, Local Housing Authority, Building Managers	Feb. 20/84 to Mar. 2/84
. Building Managers: review action item list; define retrofit measures; specify implementation program for retrofit measures	Building Managers, Local Housing Authority, Local Consultant (if requested by Building Manager)	Mar. 1/84 to Apr. 30/84
. Energy monitoring: load reference year for energy monitor; process energy bills for first months of 1984 year	EIL, Local Housing Authority	Apr. 1/84 to Apr. 30/84
. Retrofit Implementation: building managers prepare and issue contracts for retrofit measures and/or implement no cost/low cost measures	Building Managers, Local Housing Authority, Local Consultant	Apr. 1/84 to Mary 31/84
. Workshop Presentation #2: review program objectives; review site visit reports and retrofit measures; present Energy Monitors	Building Managers, CMHC, EIL, Local Housing Authority, Local Consultant	May 1/84 to May 16/84

TASK	RESPONSIBILITY	TIMETABLE
. Energy Monitoring: process energy bills; Monitor and send results to Local Housing authority and Building Managers	EIL, Local Housing Authority	Apr. 1/84 to Dec. 31/84

The project methodology requires participation from a number of organizations. Each organization, in turn, must seek cooperation from its own levels of building management. A summary listing of the organizations and managers involved in this project is given below:

CMHC	- Project Coordinator in Ottawa
Provincial Housing Authority	- Director of Property Services - Manager of Operation/Maintenance - Property Managers
Local Housing Authority	- Property Managers - Maintenance Staff - Building Superintendents/Managers

NOTE: A local housing authority is present in Alberta and Quebec but not in British Columbia.

Local Consultant	Principal Engineer Support Staff
Prime Consultant (EIL)	Principal Engineer Support Staff

The workshop sessions incorporated in this program are critical to the organization, motivation and commitment of all persons involved in this project. Workshop sessions also provide an important communication medium for the coordination of managers.

Provincial housing authority personnel and local consultants gathered the required data for the energy audit and analysis phase of the project. The local consultant carried out the following functions:

- meet with the provincial housing authority, CMHC and EIL to
  - review the project plan;
  - discuss possible buildings to be selected,
  - discuss possible workshop groupings and content, and
  - assess interest and capabilities of housing authorities in direct computer access to the database developed for this project;
- receive direction from EIL and the provincial housing authority as to final selection of buildings and data requirements;
- contact housing authorities, building managers, or utilities to obtain at least a one year utility consumption history;
- transcribe all utility data onto EIL forms and forward to EIL;
- contact provincial authorities or building managers to obtain access to architectural and mechanical drawings;
- abstract, from drawings, the data required for the EIL building information file, and forward to EIL.

Data was submitted to EIL on the forms shown in Appendix A.

3.0 ENERGY ANALYSIS

The EIL proprietary SUMAC computer based energy information system was used for energy analysis. The interpretation of the energy information required some understanding of the analytical methods used in the SUMAC Audit and Target computer programs. The concept of the SUMAC Audit program is reviewed briefly in Section 3.1, with additional information contained in Appendix B. The SUMAC Target program is outlined in Section 3.2, with additional information contained in Appendix C. The analytical data is presented in Section 3.4.

3.1 Energy Audit

The energy use for fuel, electricity and electrical demand was separated into discrete components which related to specific building systems.

The size of each energy component in a current year can be compared to:

- a previous year,
- values achieved in other similar buildings,
- expected values for this building.

In this manner, clues are obtained as to where excess energy use problems occur.

There are eight energy components in the SUMAC Audit. The energy systems and operations typically associated with them are shown below.

Non-Weather sensitive fuel	Domestic Hot Water, Process Loads, Standing Losses and Central Losses from Heating Systems Operated in Summer months.
Weather sensitive fuel	Envelope Loss, Ventilation, Air Leakage, Snow Melting, Humidification, Garage Heating
Base electricity consumption	Lights, Fans, Pumps, Elevators
Winter extra electricity consumption	Electric Heating, Seasonal Electric Loads
Summer extra electricity consumption	Air Conditioning, Seasonal Electrical Loads
Base electric demand	Lights, Fans, Pumps, Elevators
Winter extra electric demand	Electric Heating, Seasonal Electrical Load
Summer extra electric demand	Air Conditioning, Seasonal Electrical Load

The SUMAC program normalizes for variations in weather and billing period length.

The normalization process removes variability due to weather, location, and billing periods from the investigation of apparent high and low energy performance.

Weather normalization adjusts for two variables:

- Year to year weather differences. After separating weather dependent components from total use, they can be adjusted to account for weather variations, from year to year, at any one location. Each year's performance is normalized back to an arbitrary standard year's actual weather conditions for that location.
- Buildings in different locations. Energy performance of buildings in different climates can only be compared if an appropriate climate adjustment is made. SUMAC can adjust the weather dependent energy components of a building, in any location, to weather conditions elsewhere.

Billing period length normalization adjusts all consumption to a standard year length of 365.25 days.

The SUMAC Audit provides both an energy summary and an energy cost summary. The energy cost summary is derived by extending actual energy use for the year by the current utility rate for each fuel.

3.2 Energy Target

The ENERGY TARGET for a building is the lowest energy use required for a building to provide environmentally acceptable conditions. The energy target is derived from the unique characteristics for

the building, its location and specific assumptions concerning interior room temperatures, ventilation rates, light levels and building system efficiencies. The energy target assumes the efficient operation of the building for its occupancy and use patterns.

The target program uses two forms of information in order to calculate target energy consumption for each building:

1. building characteristics described in the questionnaire such as floor area, wall areas, window area, number of suites, etc.;
2. assumptions concerning building variables which cannot be easily measured in each building.

Examples of key assumptions used in the energy target calculation are:

- the volume of hot water used per suite and, hence, the energy for hot water use,
- the target lighting load per unit of floor area for the building type,
- the target combustion efficiency for fuel fired boilers,
- the quantity of outside air used for ventilation purposes,
- the assumed value of air infiltration per unit of outside wall area, and
- the energy use for laundry rooms, workshops, car plug-ins, etc.

The energy target is developed for the building using information obtained from the building questionnaire. Target information on energy use is also separated into the eight SUMAC components discussed in Section 3.1. The potential energy saving is the energy use difference between the Actual Energy Use and the Target Energy Use. Potential savings are also summarized into the eight SUMAC components. Potential energy savings can now be related to specific building systems for the ACTION programs.

3.3 Energy Database System

The housing authorities participating in the program did not have specific computer programs designed for energy management of their building stock. Energy conservation measures carried out by the housing authorities were monitored by informal management feedback and by the financial reporting system. Financial reporting systems report on energy cost; however, they do not normalize energy costs for utility rate changes or weather pattern differences.

The formation of a database system, for building energy management and maintenance management, can significantly reduce building operating costs. A database system of building information will provide the cornerstone for effective management reporting on energy management and maintenance programs.

A database was developed for the management of the building information in this project, using a relational database system called INGRES. This system allows the potential user to quickly establish TABLES for information and data storage. INGRES software provides standardized procedures for data input and retrieval with no computer programming. The system was demonstrated to the Société d'habitation du Québec and a summary of this presentation is outlined in Appendix I.

3.4 Energy Analysis Results

The SUMAC Audit and Target results for each building are summarized in Appendix D. Results are presented in both energy consumption form (Megajoules/square Metre/year) and energy cost form (thousand of dollars/year). All weather sensitive energy use has been normalized to a standard weather reference year.

A summary of energy use information and energy cost saving potential is outlined, for each building, in Figures #2 and #3. The energy cost saving potential is based on the difference between 1983 energy cost and the equivalent cost for the building energy target. Total energy cost savings identified are $610,500, or 33% of current energy cost.

CMHC ENERGY UPGRADING PHASE II
1983 ACTUAL ENERGY USE
(NORMALIZED TO TORONTO WEATHER CONDITIONS)

		ENERGY IN MJ/SQ.M./YEAR						ELECTRIC DEMAND IN WATTS/SQ.M.			
SHORT BLDG NAME	PROV	NON WEATH SENS. FUEL	WEATHER SENSITIVE FUEL	BASE ELEC. CONS.	WINTER EXTRA ELEC. CONS.	SUMMER EXTRA ELEC. CONS.	TOTAL ENERGY	BASE	WINTER EXTRA	SUMMER EXTRA	TOTAL DEMAND
LEVIS	QUE	0	0.000	272	189.900	33	494.900	0.000	0.000	0.000	0.000
LAUZ	QUE	0	0.000	305	178.250	39	522.250	0.000	0.000	0.000	0.000
DRUM	QUE	0	0.000	283	267.375	-10	540.375	15.800	16.140	-0.200	31.740
5630	QUE	0	0.000	309	267.375	22	598.375	15.700	16.140	2.700	34.540
ENTEN	QUE	0	0.000	287	267.375	67	601.375	19.000	18.292	3.100	40.392
EDWAR	ALA	18	244.125	336	11.625	1	610.750	14.400	1.076	0.300	15.776
BOURL	QUE	0	0.000	335	240.250	41	616.250	18.800	13.938	2.300	35.088
COKOS	QUE	0	0.000	400	190.000	32	622.000	0.000	0.000	0.000	0.000
SAUV	QUE	0	0.000	367	302.250	9	678.250	24.900	12.912	-0.700	37.112
5600	QUE	0	0.000	359	364.250	-15	708.250	32.200	16.140	-3.400	44.940
BRIDG	ALA	223	406.875	74	23.250	7	734.125	3.700	1.076	0.100	4.976
PIONN	QUE	0	0.000	413	290.300	48	751.300	0.000	0.000	0.000	0.000
CAROL	BC	548	453.375	39	3.875	0	1044.250	0.000	0.000	0.000	0.000
MOUNT	ALA	188	627.750	233	34.875	6	1089.625	14.000	2.152	0.000	16.152
EAU	ALA	471	507.625	105	11.625	0	1095.250	5.500	0.000	0.000	5.500
ODDF	ALA	128	705.300	252	23.200	0	1108.500	14.300	1.076	0.000	15.376
KING	ALA	294	697.500	262	3.875	4	1261.375	14.200	0.000	0.300	14.500
HALL1	BC	537	670.375	101	0.000	0	1308.375	5.500	0.000	0.100	5.600
HALL2	BC	579	623.875	121	3.875	0	1327.750	6.500	0.000	0.000	6.500
GRACE	ALA	332	809.900	208	34.900	12	1396.800	13.600	1.100	0.200	14.900
CARRO	ALA	354	674.250	321	42.625	16	1407.875	17.400	1.076	0.200	18.676
SUNNY	BC	375	806.000	228	23.250	1	1433.250	0.000	0.000	0.000	0.000
BAKER	ALA	269	844.750	299	27.125	2	1441.875	14.300	0.000	-0.400	13.900
ROSS	BC	483	802.125	206	23.250	3	1517.375	0.000	0.000	0.000	0.000
KUHN	BC	622	825.375	102	7.750	0	1557.125	4.300	0.000	0.000	4.300
NICHO	BC	627	643.250	265	65.875	4	1605.125	0.000	0.000	0.000	0.000
SHEP	BC	650	658.750	249	54.250	4	1616.000	0.000	0.000	0.000	0.000
GRAND	BC	857	492.000	169	19.400	0	1537.400	9.900	0.000	0.000	9.900
CARTE	ALA	463	767.250	434	38.750	34	1737.000	19.700	1.076	2.100	22.876
MACLN	BC	2184	2178.000	96	7.800	0	4465.800	5.800	0.000	0.100	5.900

(30 ROWS)

FIGURE 2

CMHC ENERGY UPGRADING PHA II
ENERGY COST SAVINGS POTENTIAL
ALL BUILDINGS

(IN THOUSANDS OF DOLLARS)

SHORT BLDG NAME	PROV	NON-WEATHER SENSITIVE FUEL	WEATHER SENSITIVE FUEL	BASE ELEC. CONS.	WINTER EXTRA ELEC. CONS.	SUMMER EXTRA ELEC. CONS.	BASE DEMAND	WINTER EXTRA DEMAND	SUMMER EXTRA DEMAND	GRAND TOTAL
CAROL	BC	5.500	0.000	-6.700	0.100	0.000	0.000	0.000	0.000	-1.100
LEVIS	QUE	0.000	0.000	-0.100	0.200	3.000	0.000	0.000	0.000	3.100
EDWAR	ALA	-2.500	-3.000	6.400	0.800	0.100	5.700	0.000	0.000	7.500
SUNNY	BC	3.900	3.300	0.200	0.700	0.100	0.000	0.000	0.000	8.400
ROSS	BC	6.000	1.400	-0.100	1.200	0.200	0.000	0.000	0.000	8.700
MOUNT	ALA	0.900	1.500	0.600	1.300	0.300	4.300	0.000	0.000	8.900
GRAND	BC	8.100	-1.700	1.700	0.500	0.000	0.200	0.000	0.000	8.800
COROS	QUE	0.000	0.000	9.900	-3.200	3.000	0.000	0.000	0.000	9.700
DRUMM	QUE	0.000	0.000	0.200	14.300	-1.800	0.000	0.000	0.000	12.700
GRACE	ALA	2.000	6.300	-0.500	1.600	0.200	3.100	0.000	0.000	12.700
EAU	ALA	4.200	5.100	1.300	0.600	0.000	1.600	0.000	0.000	12.800
ODDF	ALA	0.200	7.200	1.000	1.100	0.000	3.400	0.000	0.000	12.900
5630	QUE	0.000	0.000	-0.300	5.300	1.500	0.100	5.800	2.100	14.500
SAUV	QUE	0.000	0.000	1.900	6.400	0.300	3.800	3.000	-0.300	15.100
LAUZ	QUE	0.000	0.000	1.900	7.100	6.300	0.000	0.000	0.000	15.300
BOURL	QUE	0.000	0.000	-0.700	1.500	4.400	2.100	5.100	3.100	15.500
SHEP	BC	10.200	1.000	2.900	2.000	0.300	0.000	0.000	0.000	16.400
5600	QUE	0.000	0.000	1.900	6.600	-0.800	9.700	3.400	-2.200	18.600
KING	ALA	3.800	10.600	1.200	0.200	-0.400	4.000	0.000	-0.600	18.800
BRIDG	ALA	1.600	8.000	3.900	1.500	1.000	2.800	0.800	0.100	19.700
CARRO	ALA	3.900	7.700	3.100	1.900	0.800	3.200	0.700	0.100	21.400
PIONN	QUE	0.000	0.000	6.500	11.500	4.000	0.000	0.000	0.000	22.000
NICHO	BC	13.400	-0.100	1.400	7.200	0.200	0.000	0.000	0.000	22.100
HALL1	BC	15.500	3.000	3.500	0.400	0.000	0.300	0.000	0.000	22.700
HALL2	BC	13.600	4.400	4.200	0.300	0.000	0.500	0.000	0.000	23.000
ENTEN	QUE	0.000	0.000	-0.600	18.100	7.600	0.000	0.000	0.000	25.100
BAKER	ALA	-0.100	16.100	4.100	2.600	0.200	2.400	1.000	-0.400	25.900
KUHN	BC	19.400	8.200	1.300	0.800	0.000	0.000	0.000	0.000	30.200
CARTE	ALA	9.300	11.900	12.000	2.800	2.000	5.800	1.300	1.300	46.400
MACLN	BC	41.000	24.700	1.600	0.500	-0.100	0.000	0.000	0.000	67.700
										546.200

FIGURE 3

Average energy use, calculated in the Phase I report, for this category of buildings is compared with the high, low and median energy use values for the ten buildings in each province as follows:

Energy Use MJ/m. sq./yr.

	Low	High	Median	Phase I Report
Quebec	495	751	610	750 (Average for all electric buildings)
Alberta	611	1,737	1,185	1,765 (Average for fuel fired building)
B.C.	1,044	4,465	1,537	1,765

NOTE: Phase I Report averages were calculated for buildings using a reference year of Toronto weather.

The weather sensitive energy use for each building has been normalized to Toronto weather. The normalization process allows for direct comparison of energy use on an equivalent basis. Toronto weather is selected as the reference city since the weather patterns of Toronto are judged to be average for Canadian buildings.

The energy use is below the historical average use for this category of buildings. The energy cost savings from this sample of thirty buildings is, therefore a conservative estimate of attainable savings in the entire public housing stock of multi-unit buildings with central utilities.

The average energy cost for each building group, and the ultimate target energy cost, is summarized below in dollars per square metre of floor area:

	1983 Energy Cost	Target Energy Cost	Savings	Savings %
Quebec	$8.40	$6.80	$1.60	19%
Alberta	$5.90	$3.90	$2.00	34%
B.C.	$6.10	$3.70	$2.40	39%

The energy targets and actual energy cost are compared graphically for each building in Figures #4, #5 and #6. The results show significant variations in actual energy cost per unit area among the buildings, due primarily to differences in window area and ventilation/exhaust air flows. High energy cost per unit area does not necessarily mean a large potential energy savings. For example, buildings with large glass areas per unit of floor area will have higher energy cost for heating and a higher target for heating fuel use.

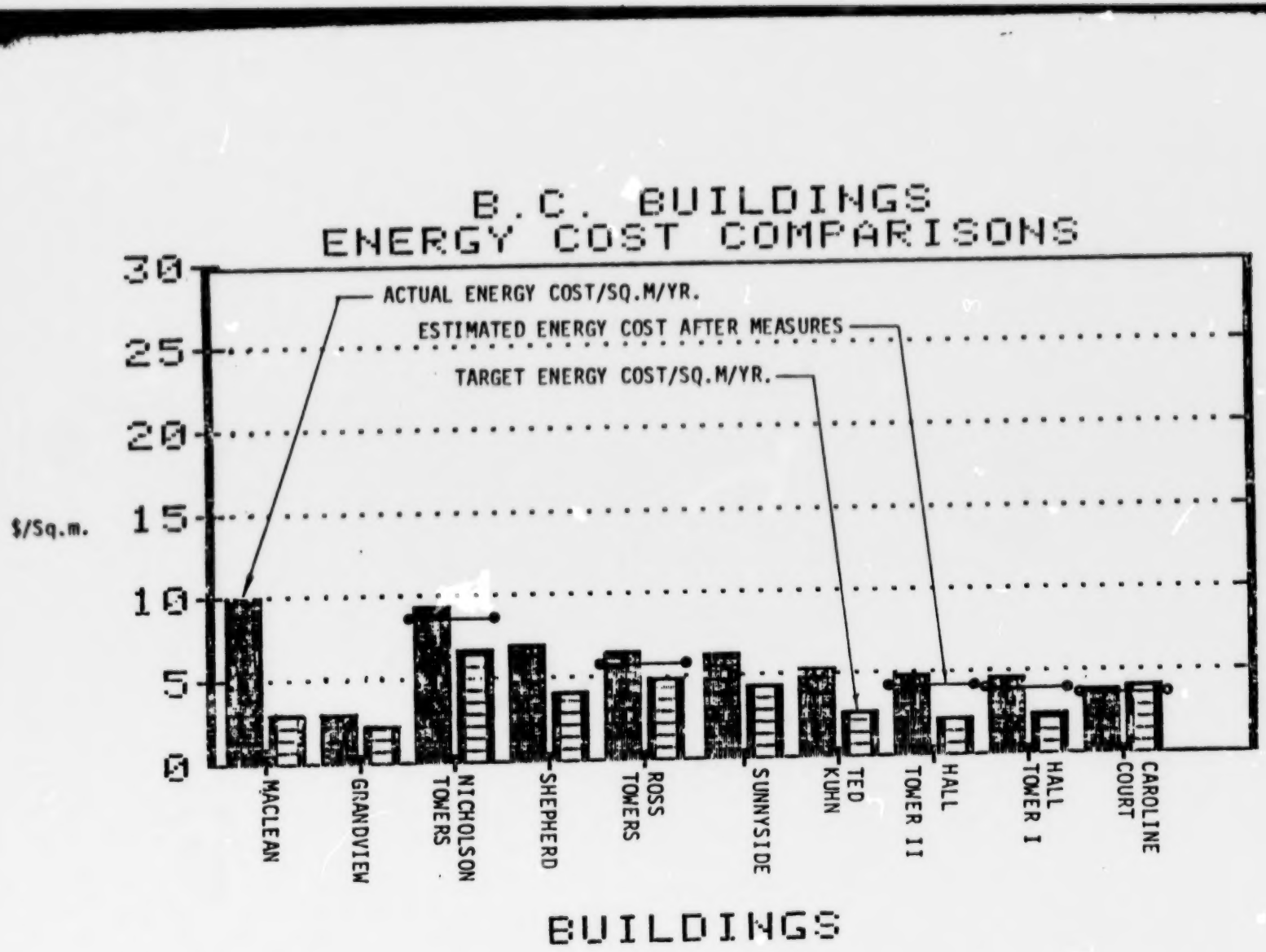

B.C. BUILDINGS
ENERGY COST COMPARISONS
ACTUAL ENERGY COST/SQ.M/YR.
ESTIMATED ENERGY COST AFTER MEASURES
TARGET ENERGY COST/SQ.M/YR.
$/Sq.m.
30
25
20
15
10
5
0
MACLEAN
GRANDVIEW
NICHOLSON TOWERS
SHEPHERD
ROSS TOWERS
SUNNYSIDE
TED KUHN
HALL TOWER II
HALL TOWER I
CAROLINE COURT
BUILDINGS

FIGURE 4

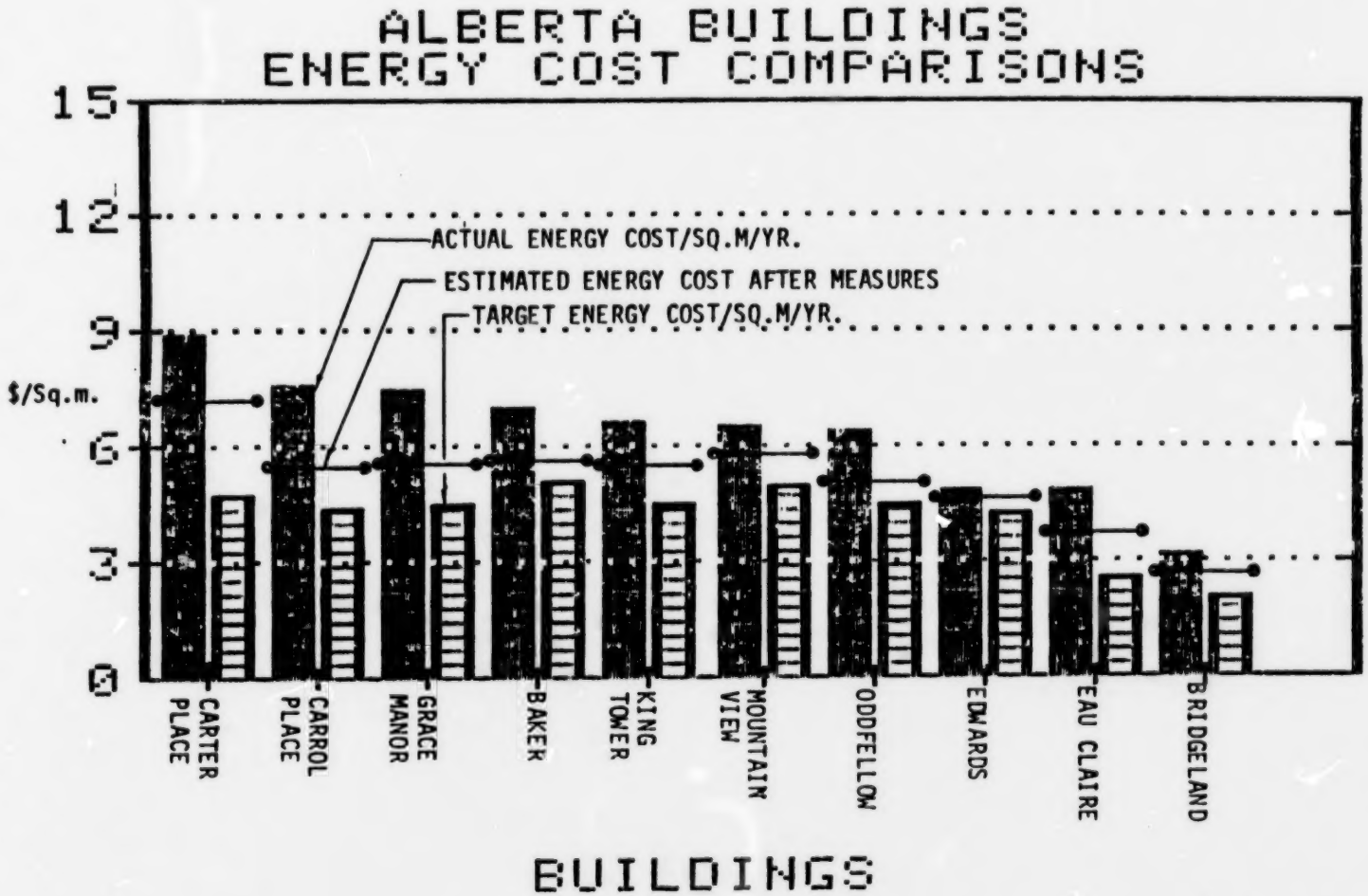

ALBERTA BUILDINGS
ENERGY COST COMPARISONS
15
12
9
6
3
0
$/Sq.m.
ACTUAL ENERGY COST/SQ.M/YR.
ESTIMATED ENERGY COST AFTER MEASURES
TARGET ENERGY COST/SQ.M/YR.
CARTER PLACE
CARROL PLACE
GRACE MANOR
BAKER
KING TOWER
MOUNTAIN VIEW
ODDFELLOW
EDWARDS
EAU CLAIRE
BRIDGELAND
BUILDINGS

FIGURE 5

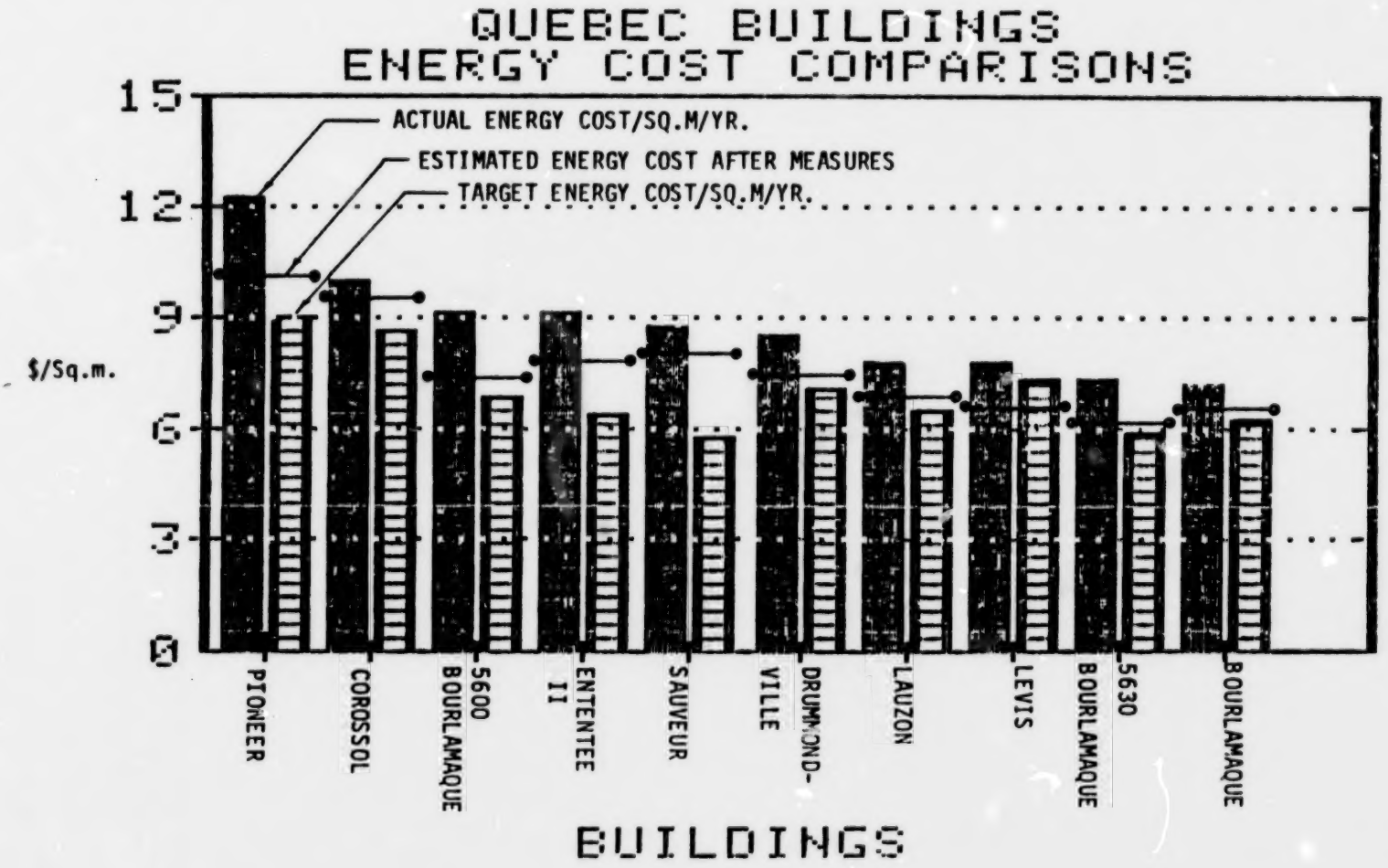

QUEBEC BUILDINGS
ENERGY COST COMPARISONS
ACTUAL ENERGY COST/SQ.M/YR.
ESTIMATED ENERGY COST AFTER MEASURES
TARGET ENERGY COST/SQ.M/YR.
$/Sq.m.
15
12
9
6
3
0
PIONEER
COROSSOL
5600 BOURLAMAQUE
ENTENTEE II
SAUVEUR
DRUMMOND-VILLE
LAUZON
LEVIS
5630 BOURLAMAQUE
BOURLAMAQUE
BUILDINGS

FIGURE 6

The first workshop reviewed the differences between actual energy cost and target energy cost for each building. As noted in Appendix D, the energy audit compared energy cost to target for the eight SUMAC components of energy use. The energy cost saving potential is related to the building systems that affect energy use in each SUMAC component. A building site visit, in turn, may be required in order to isolate the most cost-effective retrofit measures. The site visit is directed by the energy audit findings. For example, a high weather sensitive fuel consumption will direct the site visit toward energy conservation measures associated with weather sensitive fuel usage. Retrofit measures are discussed in greater detail in Section 4.0 of this report.

The energy use analysis showed certain common trends for each province.

Quebec

Quebec buildings selected for this program were all electric buildings with individual room controls for heating. Some buildings are charged for electric demand by the utility.

Common measures identified for Quebec buildings were domestic hot water temperature reduction, domestic hot water set-back at night, time cycling of ventilation exhaust, lighting reduction, and lighting conversions.

Application or modification of demand control devices was investigated in buildings with demand sensitive electricity rates.

Alberta

Alberta buildings selected for this program were all fuel heated buildings using natural gas. All buildings incorporated some form of individual room control for heating.

Common measures identified for Alberta buildings were domestic hot water temperature reduction, domestic hot water set-back at night, reduction of ventilation air flow and exhaust air flow, time cycling of ventilation exhaust, lighting reduction and conversions.

Some Alberta buildings did not have separate domestic hot water boilers. For these buildings, measures addressing shutdown of heating circuits in summer were suggested.

British Columbia

British Columbia buildings selected for this program were all fuel heated buildings using natural gas. Some buildings incorporated individual room controls for heating while other buildings relied on outdoor temperature sensors for scheduling heating water temperatures.

Common measures identified for British Columbia buildings were domestic hot water temperature reduction, domestic hot water set-back at night, reduction of ventilation air flow and exhaust air flow, time cycling of ventilation exhaust, lighting reduction and conversions.

The B.C. buildings showed a high non-weather-sensitive baseload of fuel use. This condition is normally symptomatic of poor heating system control and large thermal losses in distribution piping for heating circuits.

3.5 Procedural Problems

Difficulties encountered during the data collection phase were similar for all provinces and are as follows:

- Utility bills are often difficult to extract from accounting files, data collection is dependent on organization of accounting files for the buildings.

- In some cases one utility meter may record energy use for more than one building making correlation of energy use to buildings characteristics more difficult;

- The housing authority records do not clearly indicate buildings which are jointly metered by a single utility meter - this problem was most significant for B.C. buildings where several complexes have one fuel meter for a building complex;

- Building plans and drawings are often not readily available - in most cases the drawings are not "as built" for building mechanical systems;

- Obtaining accurate building information from building drawings proved to be more difficult than anticipated;

- The definition of the exact number of apartment suites for each building was sometimes a problem - property management records differed from the building drawings; and

- Definition of the building area was difficult for buildings with unusual ground floor configurations having unheated areas.

4.0 ENERGY ACTION PROGRAM

4.1 Workshop Meetings

The purpose of the workshop in this project was to initiate and follow up on energy active programs, provide a vehicle for effective two-way communication and motivate the program participants. In order to promote effective communication, each workshop session was designed to involve approximately twelve people for a one day program. The provincial housing authority and local housing authority personnel were divided into groups of five buildings, in order to keep the size of each group at twelve people. A total of six workshop-days was required to complete each workshop session for all thirty buildings.

Workshop Session #1

The purpose of the first workshop session was:

- to review the objectives of the project;
- to discuss the program methodology and outline individual responsibilities;
- to present the concept of the SUMAC Audit and Energy Target;
- to review low-cost/no-cost energy conservation measures for multi-unit residential buildings;
- to review the energy audit and target results for each individual building;
- to identify specific energy conservation measures which may apply to each building; and
- to answer any queries resulting from the workshop discussions.

The first workshop session was primarily oriented towards presentation by the workshop leader. Two-way dialogue was possible in the last half of the day as specific energy conservation measures were discussed for each building.

The concept of a zero-based energy target evoked strong comment and concern from many workshop participants. A zero-based energy target for a building can be less than 50% of current energy consumption. Most workshop participants have some difficulty believing a 50% reduction in energy consumption is possible.

The concept of zero-based energy targets is based on optimum control and operation of existing building systems. This target poses some interesting questions for most building managers:

- Do I believe and understand the algorithms used to generate the energy target?
- Will I be held accountable to this energy target?
- How do I achieve the energy target level? and
- Does a large target variance mean I wasn't doing my job?

Many building managers have already completed energy conservation measures and were shocked to learn that significant energy cost savings were still available.

The workshop session was well received by generally participants. Provincial housing authorities appreciated the training value of the workshop session. Most participants in the workshop session asked questions relevant to their own needs, thereby increasing the perceived value of the session.

Workshop Session #2

The second workshop session was held approximately two months after the first workshop.

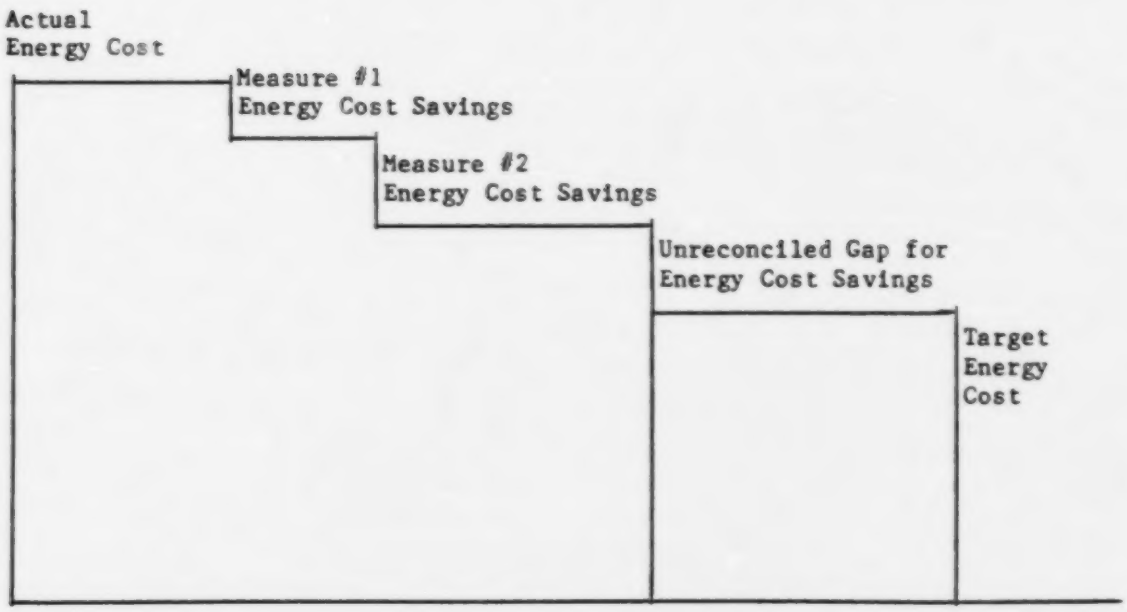
The purpose of the second workshop session was:

- to review the objectives of the project;
- to review the program methodology and individual responsibility;
- to review the concept of the SUMAC Audit and Target;
- to review measures identified to date by building managers.
- to discuss the results of any site visits by local consultants;
- to review mechanical ventilation and infiltration energy conservation measures in detail;
- to present the concept of the SUMAC energy monitor and review the first monitor for each building; and
- to review cost estimates for the implementation of energy conservation measures and project their cost savings.

The workshop participants were more involved in the second workshop since they were discussing, in concrete terms, retrofit measures related to their own buildings.

4.2 Retrofit Action Program

The retrofit action program is defined as the package of energy conservation measures identified for a given building. The energy audit and energy target helped to define the potential energy cost savings in each building. The potential energy cost savings in each building must be reconciled with the energy conservation measures actually identified. The diagram shows the reconciliation process in graphical form.



Building managers and superintendents, assisted in some cases by site visits from local consultants and provincial housing personnel, defined specific energy conservation measures for each building. The capital cost and the energy cost savings for each measure was calculated, either before or during Workshop #2. Calculation of energy cost savings during Workshop #2 helped to convey the relative importance of various retrofit measures. For example, reduction of ventilation/exhaust airflows produced much greater energy cost savings than lighting retrofits.

The energy cost savings identified through retrofit measures does not necessarily equal the potential energy cost savings in all buildings. The unreconciled gap between calculated savings and potential savings can be explained in a number of ways:

- energy target assumptions or input data were inaccurate in some respect;
- actual energy use data was inaccurate in some respect; and
- viable energy conservation measures were not identified during the site visit.

Procedural Problems

Target assumptions and input data were found to be inaccurate in some buildings. For example, the window area was incorrectly calculated in one building. In most cases where data had been missed or was incorrect, the modification to the target was less than 10%.

The recording of actual energy use from utility bills presented a few minor problems. In one Calgary building, a utility meter problem necessitated the replacement of the meter. Thus there was an aberration in energy consumption patterns due to estimated energy consumption. A utility strike in British Columbia required the proration of energy use during the January to March period of energy monitoring in 1984.

Targetted Savings

A summary of targetted savings and energy conservation measure savings (ECM) is outlined in Figure 7.

Targetted savings are the difference between actual energy cost and targetted energy cost for each building. ECM savings are the savings calculated and documented during the second workshop.

There is considerable information available from several sources on the subject of energy conservation measures in multi-unit residential buildings with central utilities. The Phase I report presented a list of forty-one measures that could be applicable to the portfolio of buildings with central utilities included in this study.

BUILDING NAME	ACTUAL ENERGY COST** $	TARGET ENERGY COST ** $	PROJECTED** SAVINGS $	CALCULATED SAVINGS $	RETROFIT COST
CARROL PLACE	48.7	27.2	21.5	12,300	1,200
EAU CLAIRE	27.3	14.4	12.9	5,700	1,000
ODDFELLOW	42.0	29.1	12.9	9,000	500
BRIDGELAND	58.8	39.1	19.7	7,000	600
BAKER	92.4	66.6	25.8	14,000	2,100
KING TOWER	58.5	39.6	18.9	7,000	1,000
EDWARDS	47.7	41.0	6.7	800	0
GRACE MANOR	31.4	18.9	12.5	7,000	800
CARTER PLACE	98.9	52.4	46.5	18,100	800
MOUNTAINVIEW	36.9	27.8	9.1	2,900	600
TOTALS FOR CALGARY	542.6	356.1	186.5	83,800	8,600
ENTENTEE II	80.0	55.7	24.3	11,500	2,400
BOUFLAMAQUE	123.5	107.1	16.4	12,700	2,200
5630 BOURL.	72.6	57.8	14.8	11,700	2,300
5600 BOUR[illegible].	74.1	55.6	18.5	11,700	2,200
CORDSSOL	70.4	60.7	9.7	3,500	1,600
LAUZON	96.6	81.3	15.3	10,700	11,500
PIONEER	81.2	59.1	22.1	14,300	8,600
SAUVEUR	43.6	28.5	15.1	3,000	1,200
LEVIS	50.7	47.7	3.0	7,800	1,800
DRUMMONDVILLE	79.0	66.3	12.7	10,100	3,600
TOTALS FOR QUEBEC	771.7	619.8	151.9	97,000	37,400
ROSS TOWERS	32.3	23.7	8.6	3,200	1,600
HALL TOWER I	49.3	26.4	22.9	3,600	500
HALL TOWER II	40.1	17.1	23.0	4,900	1,200
CAROLINE COURT	14.1	15.2	-1.1	2,100	800
NICHOLSON TOWERS	80.5	58.3	22.2	6,400	900
GRANDVIEW	26.6	17.8	8.8	NOT AVAILABLE *	
TED KUHN	59.3	29.1	30.2	NOT AVAILABLE *	
SUNNYSIDE	26.2	17.8	8.4	NOT AVAILABLE *	
MACLEAN	94.4	26.7	67.7	NOT AVAILABLE *	
SHEPHERD	38.8	22.4	16.4	NOT AVAILABLE *	
TOTAL FOR B.C.	461.6	254.5	207.1	20,200	5,000
GRAND TOTAL	1,775.9	1,230.4	545.5	201,000	51,000

* Site visits and retrofits were not proposed for these buildings as of June 1984.

** In thousands of dollars.

FIGURE 7

Over the last few years, the Ontario Housing Corporation has produced a package of documentation on measures applicable to their residential stock. Each measure is presented on a single page, together with implementation procedures and expected benefits. This allows a person with minimum training to understand the measure and either carry out the work directly or supervise its implementation.

In the course of phase two of this study, the Société d'habitation du Québec commissioned a consultant to prepare a long list of energy conservation measures applicable to their multi-unit stock with central utilities. Another source of information on applicable measures is CMHC's publication entitled "Energy Efficiency in Multi-Unit Residential Buildings: A Handbook for Owners and Operators".

The training and expert advice provided to the building superintendents and managers made it possible for them to identify measures which they felt were most applicable to their particular buildings. They investigated the application of no-cost/low-cost measures in the areas of heating boilers, heating systems, ventilation systems, lighting, and envelope tightening. Generally, only measures costing $1,000 or less were to be considered.

This strategy was particularly applicable in provinces where operation and maintenance responsibility is decentralized, such as in Quebec and Alberta. This was not applicable in British Columbia, however, as system maintenance and retrofit responsibility is centralized within the regional and main offices of the B.C. Housing Management Commission.

4.3 Provincial Programs

Quebec

The Société d'habitation du Quebec opted for the following methods of providing training and information to the local municipal housing corporation personnel.

Firstly, as a direct component of this project, the operating personnel from the ten buildings selected for this project attended the workshops described under 4.1 in 1984 and a final workshop in early 1985. Secondly, in July 1984, the Société d'habitation du Quebec hired several engineering student stagières from the École de technologie supérieure to be made available, on site, to municipal housing corporations. The students were given an intensive one week training course on energy conservation measures applicable to the type of buildings in which they would be working. Several of the municipal housing corporations involved in this study made use of these stagières. Finally, engineers from the local consulting engineering firm were made available to the municipal housing corporations for expert advice, should it be requested. The housing corporations were encouraged, however, to use these services only if absolutely necessary.

The first workshop was held in February 1984 in Verdun and in Quebec City. Each workshop involved personnel from five build-

ings. A list of specific energy conservation measures was presented in detail and discussed with the participants. The second workshop was held in May 1984 in Verdun and in Quebec City. During this workshop, the following specific measures were reviewed:

- Infiltration, including weatherstripping to doors and common areas, to the main door, to the emergency doors, to the door under the garage, to the elevator shaft openings and to the garage door;

- Weatherstripping to windows and common areas, in corridors, and emergency stairwells;

- Ventilation controls on exhaust air, corridor supply air, and garage exhaust air;

- Domestic hot water for reduction of temperature, recirculation time control and reduction of flow at shower heads;

- Installation of specialized timers on exterior car heater plug-in outlets.

- Corridor lighting for the reduction of wattages, the replacement of fixtures and the reduction of on-times; and

- Other measures such as exterior lighting and infiltration at floor level at the base of the exterior walls.

The third workshop was held in February 1985 in Verdun and in Quebec City. The status of the measures discussed at the second workshop was determined. It was noted by several participants that very few measures could be implemented in 1984 in view of capital budget restraints. They also noted, however, that several important measures would be implemented in many of the buildings in early 1985.

Three buildings implemented no measures in 1984; all remaining buildings implemented measures beginning in September 1984 only. Given the lateness of the retrofit work, it was expected that the energy savings in 1984 in Québec would be minimal.

Alberta

As in Québec, three workshops were held in Alberta. The consulting engineering firm responsible for the project in Alberta was also made available to the individual non-profit housing groups, if requested. Assistance was also provided directly through the technical personnel of the Southern Region of the Alberta Housing and

Mortgage Corporation. As in Québec, the workshop participants were encouraged to identify and implement measures, on their own, in their particular buildings. The first workshop which was held in January 1984, in Calgary.

All buildings have natural gas boilers and considerable attention was, therefore, paid to boiler efficiency and controls.

Each building was reviewed by its managers to identify applicable measures.

In May 1984, a second workshop was held in Calgary to review the work carried out to date. An energy upgrading action summary was prepared for each building. It presented the proposed action, the expected savings per year, the expected cost, the person responsible for implementation and the completion date. It was noted that much relamping work had already been undertaken since the last workshop. However, no ventilation or heating system control work had yet been undertaken.

A third workshop was held in February 1985 to review the work carried out to date and the energy savings realized up to 1 December 1984. It was noted at this workshop that every building had one or more retrofit measure implemented since the second workshop.

British Columbia

In British Colmbia, only two workshops were held. The first one was held in January 1984 in Vancouver. Building operating personel and district property managers attended this workshop. Energy retrofit measures were reviewed in detail. Following this workshop, the B.C. Housing Management Commission decided to carry out a package of heating and ventilation system control retrofits to only five of the ten buildings. Specifications were developed by the local consulting engineering firm, together with personnel from the main office of the British Columbia Housing Management Commission. Thus local building operating personnel had minimal involvement in the development of these specifications. It was the opinion of the commission that the local building superintendents would require extensive training, outside of the scope of this study, to allow them to identify energy conservation retrofit measures. It was decided that it would be much more efficient to centralize the decision making process.

The site visits, by the engineering consultant and B.C. Housing Management Commission Technical personnel did reveal that many building mechanical systems were in need of immediate repair. It was realized that considerable savings could be effected through the implementation of a detailed preventative maintenance program.

The second workshop was held in May 1984. In view of the centralized decision making process, the workshop was, in reality, an information session for building operators. Following this workshop, it was decided not to have a third workshop, as this would be of little value.

Heating and ventilation control measures were implemented in June 1984 in five buildings. Specifications were prepared for the contracting out of preventive maintenance to a private firm in 1985. This contract will include ongoing review by the maintenance firm of energy conservation retrofit possibilities and recommendations to the B.C. Housing Management Commission on their implementation. The Commission expects to realize considerable savings through this approach.

5.0 ENERGY MONITORING AND SAVINGS

5.1 Energy Monitoring

The monitor and review phase of any program is designed to determine the effectiveness of the program. Energy monitoring normally tracks energy consumption and energy cost against some reference level. A reference level is usually energy consumption in a previous year or a targeted level of energy consumption.

An energy monitor program must address a number of normalization issues in order to compare current energy consumption and energy cost with a reference level:

- variations in weather patterns from month to month and year to year;
- variations in the meter reading period (period is not always 30 days and is not related to a calendar month);
- changes in units of measure (British to Metric);
- changes in building operation or occupancy; and
- changes in utility pricing.

The objectives for energy monitoring in this program are:

- to provide feedback to housing agencies and building managers about energy cost savings;

- to quantify energy cost savings compared to previous energy cost in 1983; and
- to motivate building managers to pursue energy cost savings.

A SUMAC monitor program set-up for each building was designed to accomplish these objectives.

SUMAC Monitor is a computer program which provides monitoring of energy consumption and energy cost in buildings. The computer program normalizes weather and utility billings, but does not address a change in building operation or occupancy. For example, an increase in the vacancy rate for an apartment will produce an energy cost savings for overall electricity cost paid by the tenants and the housing agency. The SUMAC Monitor will identify the energy cost savings but will not relate the savings to a change in the vacancy rate. The capabilities of the program are reviewed in Appendix B.

The reference level of energy consumption was chosen as the 1983 consumption for most buildings. The monitor report calculates the energy cost savings for each month as follows:

$$\left[\begin{array}{l}\text{Energy Consumption in} \\ \text{Some Period 1983}\end{array} - \begin{array}{l}\text{Energy Consumption in} \\ \text{Current Period 1984}\end{array}\right] \times \begin{array}{c}\text{Current Cost} \\ \text{of the} \\ \text{Energy Fuel}\end{array}$$

The normalization factors are used to adjust the equation to produce an accurate energy cost saving. Negative numbers represent an increase in energy cost. Energy cost savings are reported separately for fuel use, electricity use and electricity demand.

5.2 Energy Savings

Total 1984 Energy Savings

Figures 8, 9 and 10 present energy monitor results.

As mentioned in Section 4, the energy retrofit measures for the set of ten fuel fired buildings in Alberta and the set of ten fuel fired buildings in British Columbia, were implemented over a period starting in May 1984 and ending in November 1984.

Savings for the entire year of 1984, for these twenty buildings, averaged 4.5%. This is consistent with results of studies in Ontario where a 1981 to 1983 study indicated an average savings of 5.8% in fuel-heated buildings.

The set of ten, all-electric buildings in Quebec showed much lower savings for the full 1984 year. The full set had an average savings of only 1%. The major reason for this is purchasing delays in implementing energy conservation measures, as well as the lower potential for energy savings in all-electric buildings. These sav-

BUILDING NAME	AREA M2	BASE YEAR FUEL $	SAVINGS %	BASE YEAR ELEC $	SAVINGS %	TOTAL SAVINGS $	TOTAL SAVINGS %
BRITISH COLUMBIA							
ROSS TOWERS	5016	21486	9	13026	1	2168	6
HALL TOWER I	11195	37051	7	14949	0	2840	5
TED KUHN II	11280	49620	11	15016	2	5772	9
LEN SHEPERD	5678	21261	-2	17788	5	629	2
HALL TOWER II	8372	29187	9	13157	3	3052	7
CAROLINA CT.	3813	12790	9	2375	9	1357	9
SUNNYSIDE MR.	4260	15201	6	11961	-1	822	3
NICHOLSON TRS.	8689	35414	-3	27602	1	-666	-1
GRANDVIEW TER.	3948	46543	-3	9206	2	-1169	-2
MACLEAN PK.	5869	145816	4	7915	0	6359	4
		414369		132995		21164	
Quebec							
LE COROSSOL	7084	0	0	66137	-1	-604	-1
LE PIONEER	6633	0	0	73669	4	2866	4
DRUMMONDVILLE	9373	0	0	75064	-5	-3695	-5
DE LAUZON	12532	0	0	91647	-5	-4146	-5
ENTEE II	8853	0	0	76255	-5	-3892	-5
LEVIS	6596	0	0	49380	-11	-5301	-11
5600 LASALLE	8180	0	0	88437	12	10688	12
5630 LASALLE	9960	0	0	88242	2	2077	2
BOURLAMAQUE	17221	0	0	140386	0	40	0
STE. SAUVER II	5030	0	0	53654	7	3542	7
		0		802871		1575	
Alberta							
ODDFELLOW REB.	6707	17805	0	24876	5	1176	3
CARTER PL.	11176	41824	5	65137	5	5050	5
EDWARDS PL.	10005	34207	18	41986	6	8932	12
BAKER HOUSE	13331	44953	3	51734	3	2876	3
CARROLL PL.	6438	21599	14	31000	7	5072	10
MOUNTAINVIEW	5713	14877	1	21684	6	1464	4
EAU CLAIRE	5815	17335	3	9877	11	1605	6
GRACE MANOR	4264	15223	7	15980	6	1936	6
KING TOWER	8993	28445	25	31773	11	10784	18
BRIDGELAND II	19463	36094	3	24219	-2	725	1
		272362		318266		39620	

~~Figure 8a~~ Figure 8 Summary of 1984 Energy Monitor Results

BUILDING NAME	AREA M2	BASE YEAR ENERGY USE ekwh/M2 *	BASE YEAR ENERGY COST $/M2	SAVINGS $/M2	SAVINGS %
ROSS TOWERS	5016	420.9	6.88	0.43	6
HALL TOWER I	11195	363.8	3.75	0.25	5
TED KUHN II	11280	431.5	5.73	0.51	9
LEN SHEPERD	5678	449.6	6.88	0.11	2
HALL TOWER II	8372	368.0	5.05	0.36	7
CAROLINA CT.	3813	289.9	3.98	0.36	9
SUNNYSIDE MR.	4260	398.2	6.38	0.19	3
NICHOLSON TRS.	8689	446.0	7.25	-0.76	-1
GRANDVIEW TER.	3948	1021.2	14.1	-0.29	-2
MACLEAN PK.	5869	2167.0	26.1	1.08	4
		6356.1	86.1		
LE COROSSOL	7084	172.8	9.33	-0.08	-1
LE PIONEER	6633	232.6	11.10	0.43	4
DRUMMONDVILLE	9373	150.2	8.0	-0.39	-5
DE LAUZON	12532	144.5	7.31	-0.33	-5
ENTEE II	8853	167.3	8.61	-0.43	-5
LEVIS	6596	137.2	7.48	-0.80	-11
5600 LASALLE	8180	196.2	10.81	1.30	12
5630 LASALLE	9960	166.7	8.85	0.20	2
BOURLAMAQUE	17721	170.8	8.15	0.0	0
STE. SAUVER II	5030	188.4	10.66	0.71	7
		1726.7	90.3		
ODDFELLOW REB.	6707	307.6	6.36	0.17	3
CARTER PL.	11176	482.8	9.57	0.45	5
EDWARDS PL.	10005	390.2	7.62	0.89	12
BAKER HOUSE	13331	401.4	7.25	0.21	3
CARROLL PL.	6438	390.7	8.17	0.78	10
MOUNTAINVIEW	5713	302.7	6.39	0.25	4
EAU CLAIRE	5815	304.5	4.68	0.27	6
GRACE MANOR	4264	388.1	7.31	0.45	6
KING TOWER	8993	350.8	6.69	1.20	18
BRIDGELAND II	19463	203.0	3.09	.03	1
		3521.8	67.13		

* All weather sensitive energy components are normalized to a standard reference of 3164°C degree days (Toronto)

~~Figure 8b~~ Summary of 1984 Energy Monitor Results

~~Table 2~~ Figure 9

BUILDING NAME	TARGETED SAVINGS $	CALCULATED SAVINGS $	RETROFIT COST	SAVINGS FULL YEAR ESTIMATE	1984 MONITORED SAVINGS
Carrol Place	21,500	12,300	1,200	11,500	5,072
Eau Claire	12,900	5,700	1,000	2,300	1,605
Oddfellow	12,900	9,000	500	1,800	1,176
Bridgeland	19,700	7,000	600	2,500	725
Baker	25,800	14,000	2,100	5,700	2,876
King Tower	18,900	7,000	1,000	8,300	10,784
Edwards	6,700	800	0	12,000	8,932
Grace Manor	12,500	7,000	800	3,000	1,936
Carter Place	46,500	18,100	800	6,900	5,050
Mountainview	9,100	2,900	600	1,600	1,464
~~Totals for Calgary~~	186,500	83,800	8,600	55,600	39,620
*Savings %	32%	14%		9%	4.5%
Ententee II	24,300	11,500	2,400	0	(3,892)
Bourlamaque	16,400	12,700	2,200	14,500	40
5630 Bourl.	14,800	11,700	2,300	8,000	2,077
5600 Bourl.	18,500	11,700	2,200	17,100	10,688
Corossol	9,700	3,500	1,600	4,000	(604)
Lauzon	15,300	10,700	11,500	3,600	(4,146)
Pioneer	22,100	14,300	8,600	5,200	2,866
Sauveur	15,100	3,000	1,200	3,500	3,542
Levis	3,000	7,800	1,800	0	(5,301)
Drummondville	12,700	10,100	3,600	5,000	(3,695)
~~Totals for Quebec~~	151,900	97,000	37,400	60,900	1,575
*Savings %	19%	12%		8%	1%
Ross Towers	8,600	3,200	1,600	2,900	2,168
Hall Tower I	22,900	3,600	500	3,900	2,840
Hall Tower II	23,000	4,900	1,200	4,400	3,052
Caroline Court	-1,100	2,100	800	2,000	1,357
Nicholson Towers	22,200	6,400	900	0	(666)
Grandview	8,800	n/a	0 ~~n/a~~	n/a	(1,169)
Ted Kuhn	30,200	n/a	0 ~~n/a~~	n/a	5,772
Sunnyside	8,400	n/a	0 ~~n/a~~	n/a	822
MacLean	67,700	n/a	0 ~~n/a~~	n/a	6,359
Shepherd	16,400	n/a	0 ~~n/a~~	n/a	629
~~Totals for B.C.~~	207,100	20,200	5,000	13,200	21,164
*Savings %	38%	10%**		6%**	4.5%**
Grand Total	545,500	201,000	51,000	129,700	62,359

n/a = not ~~available~~ calculated ~~5 buildings were not retrofitted~~

*Savings % is calculated as ENERGY COST SAVINGS x 100%
TOTAL ENERGY COST (1984 PRICES)

**Savings % based on 5 buildings

~~Figure 9~~ Summary of Energy Savings

ings are consistent with the findings of the Ontario study where the average savings in the first year was 1.5% for all-electric buildings. It should be noted that two measures which could result in significant savings were not implemented in 1984, in the Quebec buildings. These are "ventilation fan time clocking" and "parking lot car plug-in controls".

The estimated 1985 savings, resulting from the measures implemented in 1984 and early 1985, are expected to be an average of 8% for the set of twenty fuel-heated buildings and an average of 4% for the set of ten all-electric buidings.

The actual 1984 dollar savings in the set of twenty fuel-heated buildings, was $60,784.00. The actual dollar savings in 1984, for the set of ten electric buildings, was $1,575.00.

Energy Savings in Individual Buildings

Table 3 presents a summary of savings and costs for each of the thirty individual buildings. This table indicates a range of 1984 monitored savings, for the twenty fuel-heated buildings, from minus $1,169.00 to plus $10,784.00. All but two of the twenty buildings had positive savings.

An unexplained aberation is the savings realized in two buildings in British Columbia. These buildings had had no known energy retrofit measures carried out in them. They are the Ted Kuhn Building, with a savings of $5,772.00, and the McClean Buidling, with a savings of $6,359.00.

Within the set of ten all electric buildings in Quebec, only five had positive savings. The other five had significant negative savings. One possible explanation for this is extensive window opening by tenants in 1984, during the shoulder seasons. This is generally outside the control of the building operator.

Contrary to Ontario results, no discernable trend could be identified as to percent energy savings versus the base year energy use. The trend in Ontario, in the 1981 to 1983 study, had been towards an increase of energy savings as the base year energy use increased. This trend may reveal itself in 1985 for the thirty buildings of this study.

5.3 Return on Investment

As given in Table 3, the total costs of energy conservation retrofit, for the thirty buildings, was $51,000.00. Total savings realized in 1984 were $62,359.00.

Simple pay-back is, therefore, slightly less than one year.

Estimated savings for 1985, based on measures implemented in 1984 and early 1985, are $129,700.00.

For the set of ten fuel-heated buildings in Alberta, the simple pay-back period, based on actual savings in 1984, is less than three months. This is to be expected from the combustion efficiency and the systems time clocking type of measures implemented.

For the set of ten fuel-heated buildings in British Columbia, the simple pay-back period for actual savings in 1984 is less than five months.

5.4 Provincial Energy Information Systems

SUMAC Experience

The SUMAC energy information system, developed by engineering Interface Limited in Toronto, was utilized for this study. This system is presented, in detail, in the November 1983, Phase I report. The system was presented to the workshop participants during the first and second workshops. In general, the participants understood the concepts and procedures, but many remained unsure

about how realistic the utilimate, zero-base energy target could be.

In general, the SUMAC system was seen to be very useful for detailed investigations of the energy performance of buildings on a month to month basis.

SUMAC was recognized, also, as a very powerful tool for trouble shooting of specific buildings.

Over the last few years, software has been developed by several private firms for auditing, targetting and monitoring energy use in multi-unit residential buildings with central utilities. This software is affordable and can be made compatible with most computer hardware presently used by provincal housing authorities.

One objective of this study was to determine the requirements for developing new software to be made available to all provincial housing authorities. In view of private sector developments in this area, it has been concluded that new computer program development is unnecessary. The following initiatives have been undertaken by each province.

Quebec

The Société d'habitation du Quebec is in the process of establishing a computerized financial and management reporting system. In 1984, the SHQ established the criteria for introducing building architectural, mechanical and energy information into this system. The SUMAC energy target program was obtained from Engineering Interface Limited and modified. This program will run on microcomputers to establish the energy targets for all buildings with central utilities in the SHQ portfolio. Within a year, a simple monitoring program will be incorporated into the computerized information system. This program will probably report quarterly or semi-annually. It is felt that monthly reporting would be unnecessary.

Alberta

The Alberta Mortgage and Housing Corporation proposes, over the next twelve months, to incorporate a monitoring component to its computerized building information reporting system. The requirements for energy auditing and targeting will be further investigated in 1985.

The non-profit housing groups in Calgary that participated in the study indicated that they would welcome a monitoring service provided by the Alberta Housing and Mortgage Corporation. As in Quebec, however, it was strongly felt that this service should be backed up with ongoing training of building operators and funding for retrofit measures.

British Columbia

The British Columbia Housing Management Commission investigated the possibility of using the monitoring program developed by the Ontario Housing Corporation. It was concluded that this program did not meet the requirements of the Commission. A simple monitoring program was, therefore, developed by the computer service bureau in charge of the development of a computerized financial reporting system in 1984. This program has been developed and integrated into the system, and is now operational. The Housing Management Commission will review their requirements for an energy targetting program in 1985.

5.5 Human and Administrative Factors

The energy conservation measures implemented in the course of this study are outside of the control of the tenants of the building.

However, these measures do have an effect on the building environment and, therefore, have an impact on tenant satisfaction.

In this study, tenant groups did not have a participatory role and were generally not informed of technical changes occurring in the building. One objective of the study was to realize energy savings without negatively affecting the building environment.

In reality, however, environments do change and tenants are affected. For example, there may be objections to the relamping in certain areas of the building, for security reasons. There may be objections to time clocking the domestic hot water recirculation loop from people who take showers late at night (i.e. night shift workers). There may be objections to ventilation fan time clocking from people who are awake late at night (i.e. senior citizens) or to car plug-in controls from people who perceive that their car may not start twenty-four hours a day in case of emergency. (i.e. senior citizens).

Very few objections were raised by tenants in the course of this study. This is probably due to the low rate of implementation of the types of measures mentioned above. Objections were raised, however, to some measures in a few buildings. In one building in Calgary, the ventilation time clocking had to be stopped because of

complaints. In Quebec buildings, most tenants considered it to be their right, as per the terms of their lease, to have continuous power to their car plug-in's.

It is certain that tenant groups will be more involved, in the future, with the control of the environment in their buildings. Building owners and operators will have to assure these groups that an acceptable environmental quality is being maintained at all times.

This need not, however, significantly reduce the potential for energy conservation through retrofits to existing mechanical systems, since alternate approaches can likely be developed which have minimal adverse effects.

6.0 CONCLUSTIONS

The study results can be evaluated in three areas:

- the response from the program participants,
- the energy cost saving estimates, and
- the energy management model.

6.1 Questionnaire Results from Program Participants

A questionnaire was designed to evaluate the effectiveness of the program for each of the participants. The questionnaires were answered after the second workshop was completed. In all cases, people were not asked to identify or sign their questionnaires.

The questionnaire results are tabulated in Appendix H of this report. Participants found the workshop very useful or useful in all provinces. Most participants felt they understood the concepts of Audit, Target and Monitor. The workshop paticipants felt that all elements of the energy management program were necessary and important to the success of the program. No significant differences in questionnaire results could be found among the three provincial groups of Quebec, Alberta and B.C.

6.2 Energy Savings

The calculated savings are based on specific energy conservation measures identified for each building and the estimated energy cost savings for each measure. Calculated energy savings meet or exceed Phase I report predictions for both Quebec and Alberta buildings. The calculated savings for B.C. buildings are below the Phase I report predictions. Targetted savings, however, are significantly higher than Phase I report estimated savings for all provinces.

Energy cost reductions of 5% is attainable based on the experience with this sample of thirty buildings. Cost reduction of 10% appears to be attainable through the application of all no-cost/ low-cost measures. Further monitoring is required to confirm this.

Energy cost savings calculated for retrofit measures show paybacks of less than one year for capital investments. Capital cost for low cost measures averaged about $1,000 per building for Alberta and B.C., whereas Quebec buildings averaged $3 700 per building. A total investment of $51 000 yielded a savings of $62 000 in the first year.

6.3 Energy Management Model

The concept of the energy management model was implemented in this Phase II project. Management reporting and computer software was provided to the housing authorities in order to simulate the operation of the entire energy management model.

Analysis of the questionnaire results, shows that most participants rated elements of the energy management model as "very important" or "important". The concept of a zero-based energy target proved to be a useful element of the energy management model; however, the formal and informal comments showed that a target must be used with some care. The acceptance of the zero-based energy target presumes a complete understanding of the assumptions and algorithms used to calculate the target. Although most workshop participants grasped the significance of the zero-based target, they did not understand the mechanics of the target calculation. Building managers will resist any objective which they cannot fully understand.

The zero-based target helps to define the potential energy savings and set an ultimate objective for energy use. The top-down target, defined by application of specific energy conservation measures, defines a working objective for the building manager for a given year. Both versions of a target are useful in the energy management model.

The monitoring elements of the energy management model were perceived as "very important" by most participants. Monitor programs must incorporate well defined 'yardsticks' for building performance evaluation. Workshop participants will be motivated by regular and accurate reporting of energy cost savings. Several workshop participants from each province commented that they wanted more

follow-up sessions. They also wanted the energy monitor to continue for at least twelve months.

Experience gathered in this project has proven the basic concepts outlined in the energy management model. The energy cost savings realized by this project, and the subsequent programs, will depend upon three key factors:

- the funding made available for energy retrofit activity-project experience indicates that an average of $1,500 of capital per building is required;
- the development of a suitable management reporting system to monitor energy cost savings and evaluate effectiveness of the program for each building; and
- motivation and participation between various levels of building management, to ensure effective implementation of programs.

The success of any program will be adversely affected if one of these factors is not present. Funding availability will govern the timing of energy cost savings and is a prerequisite to any program. A management reporting system is mandatory to help focus management efforts and to provide effective written feedback to program participants. Technology transfer and training are required to ensure that energy cost savings are permanent, and not reversible, due to a lack of awareness or stoppage (because of changed priorities or changed personnel).

6.4 Recommendations

It is recommended that the 30 buildings should be monitored for a further 12 month period to verify the long term effectiveness of the measures implemented over the course of the study year. It is also recommended that CMHC assist the provincial housing authorities in all provinces and the territories to implement a computer based energy monitoring program meeting their requirements over the next few years. It is further recommended that funding assistance be provided for the implementation of energy conservation measures and that this assistance be linked to monitored energy performance.